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VIII.—Hectocotylus-*formation in* Argonauta *and* Tremoctopus *explained by Observations on similar Formations in the Cephalopoda in general.* By Professor JAPETUS STEENSTRUP*.

[With two Plates.]

THIS memoir is to be regarded essentially only as a somewhat detailed explanation of the figures on the two accompanying plates.

The principal object of these figures is to induce naturalists to examine the animals themselves for the peculiarities to which they draw attention in a general way, rather than by their means to give an exhaustive picture of the details; it would be better to reserve the latter for such figures as might be taken from living animals or freshly-caught individuals; the present figures are therefore for the most part in outline, and only the particular parts, of which a clearer representation was desirable, have been executed more in detail.

The subject which they represent is an essential deviation from the symmetrical structure, otherwise so highly characteristic of the Cuttle-fishes, which has hitherto scarcely been observed, or, if observed, not sufficiently noticed, as we shall find that in *all male individuals* of that entire great group, one of the eight (four pairs) arms surrounding the head, on *one side* of the animal, *is not only formed differently from that on the opposite side, but is even developed in such a peculiar manner for a longer or shorter space of its*

* Kongelige Danske Videnskabernes Selskabs Skrifter, 5 Räkke, naturv. og math. Afdeling, 4 Bind. 1856. Translated from the German of Professor Troschel, in Wiegmann's Archiv, 1856, p. 211, by W. S. Dallas, F.L.S.

length on this side, that it is impossible to doubt that the arm is thereby adapted to some particular purpose, of which we cannot suppose that it is of subordinate importance to the animal, because its transformation occurs in so great a number of species of the class, and bears its peculiar characters in each natural genus.

When the metamorphosis is traced from form to form, we may see distinctly, in my opinion, that the arm with its peculiar structure enters entirely or partially into the service of reproduction, and in the first case even becomes wholly unfitted for the part which it otherwise has to play, namely to act as an organ of motion (swimming or creeping) or in the prehension of food. This metamorphosed arm consequently betrays its close alliance with the Hectocotylus-formation in the two Octopod genera *Argonauta* and *Tremoctopus*, Delle Chiaje, as the recent investigations of Filippi, Verany, Vogt, and H. Müller have placed it beyond a doubt that the *Hectocotylus* or parasitic creature found so frequently upon female Argonauts and sometimes upon female *Tremoctopodes*,—which was first regarded, in accordance with the views of Delle Chiaje, as a parasitic animal or Entozoon, but subsequently, in accordance with the sagacious combinations of Kölliker, as a metamorphosed male Cephalopod destined to lead a parasitic life upon its female,—is by no means a complete organism, but only an arm of the male Cephalopod, which, being filled with semen, separates from it and adheres to the female for the purpose of fecundation. In order to understand this Hectocotylus-formation, which during the last three or four years has attracted so much of the attention of naturalists, more correctly, and in its connexions, the observations which I here bring forward will furnish an important key; but with the interest which they possess in this respect, they also unite, as it seems to me, no small importance in a systematic point of view. The peculiarity here referred to furnishes an additional hint for the comprehension of what does and what does not belong to this class, and in many cases it gives good specific characters for the distinction of nearly allied species, without considering the value which it possesses as an external [sexual] character in individuals of the same species, especially as such characters have hitherto been missed; and these are at the same time so readily intelligible and so striking to the eye, that one can hardly help wondering that they have not previously been observed and brought into use.

After these few introductory words I pass immediately to the description of the most essential differences of form in this metamorphosis represented in the figures upon the accompanying plates, merely remarking, preliminarily, that in the order in

which I state them, I have allowed myself to be guided in part by the succession in which they have occurred to me.

This, therefore, is the original reason for my commencing with the genus *Loligo*, Lamk., as I first became aware of this peculiarity by my comparative investigations of our northern species; the continuation of my investigations has, however, shown me that I may naturally start from this genus.

In the restricted genus *Loligo*, Lamk. (and therefore without the species upon which D'Orbigny subsequently founded the genus *Ommatostrephes*), all the species which I have had the opportunity of examining* have the extreme portion of the fourth left arm (ventral arm) so metamorphosed, that the acetabula or suckers, which in the opposite arm are continued quite to the apex, constantly diminishing in size, here gradually disappear; whilst the peduncles on which they are seated, on the contrary, increase in size, and become converted into long papillæ, giving the extreme part of the arm a peculiar, pectinate appearance. These papillæ always appear to be most strongly developed on the external margin of the arm, whilst those belonging to the series of acetabula on the inner† margin of the arm retain a trace of sucking-disks for a longer distance.

In the largest species of the genus *Loligo*, the so-called Atlantic form of *Loligo vulgaris*, Lamk., but which is really a distinct species, for which I have, in another memoir, proposed the name of *L. Forbesii*, Stp., the fourth left arm of the male has twenty-three pairs of acetabula regularly developed and corresponding with the suckers on the same space of the right arm; from the twenty-third pair onwards the size of the sucking-disks suddenly diminishes; and even the twenty-seventh and twenty-eighth pairs have them so small that they can only be distinctly recognized with the aid of a lens; after this the sucking-disks disappear entirely, whilst the muscular root of the peduncle becomes elevated to three or four times its ordinary height, and converted into a conical, elongated papilla. There are about forty pairs of papillæ, and therefore the same number

* Besides the Cuttle-fishes in the two museums of which I have the superintendence, or in which I am interested, namely the Zoological Museum of the University [of Copenhagen], and the Royal Museum of Natural History, I have also been enabled, by the kindness of my colleague, Professor Eschricht, to make unlimited use of the materials possessed by the Zootomical Museum of the University.

† Under the terms "inner" and "outer" margins of the dorsal and ventral arms, those will always be understood here which lie nearest to or furthest from the median plane of the animal: in the two lateral pairs of arms I employ the terms "upper" and "lower" to indicate the two corresponding margins of the arms, or the series of acetabula standing upon them.

of pairs of acetabula have been metamorphosed; they diminish in length in both rows towards the apex, but those which are placed along the outer margin of the arm are at the commencement more elongated in proportion, whilst the subsequent ones, in a certain space of the metamorphosed part of the arm, are abbreviated, and seated on its margin like small serrations (*vide* Pl. II. fig. 2*).

* The specific distinctions between *Loligo vulgaris*, Lamk., and *Loligo Forbesii*, Stp., are best derived from the size and form of the suckers on the tentacles: in *L. vulgaris* of the Mediterranean, as described and figured by D'Orbigny and Verany, and also in a form of our coasts, which may certainly be regarded as *L. vulgaris*, these are very large in the two central rows, and very small in the lateral rows, so that a transverse section of the latter is only one-half of that of the former, and their height only one-third; whilst in *L. Forbesii*, Stp., the suckers of the central rows scarcely exceed those of the lateral rows, either in transverse section or in height; and, on the whole, it appears as if the club of the tentacle had four series of suckers of equal size. In comparison with the suckers of the arms, the disks of the central rows of the tentacles in *Loligo vulgaris* are 2-3 times as large as the largest disks on the third arm, whilst in *L. Forbesii* they are scarcely one-third larger. The horny ring in the central rows of suckers in *L. vulgaris* has only one-half of its circumference finely toothed, whilst the other half is toothless, or only bears a group of 4-5 small blunt teeth (in our northern form these are indeed the only teeth on the horny ring): in *Loligo Forbesii* the ring bears numerous pointed teeth all round, and these are usually larger and smaller alternately. In this species, also, the suckers of the lateral series have the horny ring completely set with teeth of equal size, whilst in *L. vulgaris* their horny ring has high pointed teeth in the upper half, and the lower half almost toothless. In colour also, *L. Forbesii* is characterized by having the colour-sacs united into linear spots on the anterior part of the sides, and also down the ventral surface. These long, dark markings, and the nearly uniform size of the tentacular suckers, consequently distinguish this species from *L. vulgaris* at the first glance. Of both species I have only been able to examine the males on our coasts; with us, *L. Forbesii* is the largest and most common. The ordinary specimens are at least 2 feet long with the tentacles, 20 inches to the tips of the arms, 15 inches to the roots of the arms, and the mantle = 1 foot.

The figures which certainly represent *L. Forbesii* are—

Forbes and Hanley, British Mollusca, vol. i. pl. L.L.L.
Adams (H. and A.), The Genera of Recent Mollusca, pl. 4. fig. 3:

in the former place under the name of *L. vulgaris*, Lamk.; in the latter, under that of *L. magna*, Rondel.

It is also this species that I have figured in a woodcut in my memoir upon the "Sea-monk" (Sömunken); and, to judge from the suckers, it is also possibly the species represented by Borlase (Natural History of Cornwall).

As Rondelet's name "*Loligo magna*" is no systematic denomination in the Linnæan sense, this name, adopted by Leach, Gray, and others, cannot be justly regarded as prior to *L. vulgaris*, even if it cannot be abandoned for the reason adduced by D'Orbigny, because there are other *large* species; but least of all can this name be transferred to the new species, which, in the opinion of the malacologists of Southern Europe, is an Atlantic spe-

In the male of another Danish species of *Loligo*, which I regard as the *L. vulgaris* of Lamarck and the succeeding South European authors, although in particular points it does not *perfectly* agree with the more detailed descriptions, I find an accordance between the right and left arms of the fourth pair as far as the eighteenth or nineteenth pair of suckers, where a perceptible elongation of the peduncle commences. This then increases more and more towards the apex of the arm, the suckers disappearing gradually, and the peduncle remaining as a long conical papilla. The papillæ are, on the whole, rather longer and more powerful than in the preceding species, from which it also differs in having the extremely small, ringless sucking-disks visible for a somewhat longer distance, and also in that the papillæ of the inner series are the smallest at the commencement, but afterwards become the longest, especially towards the apex, where they bend inwards towards the median line of the arm, or, as it were, stretch over towards the series of the opposite side, on which the papillæ have become shorter and thicker exactly in the same proportion, and, as in the preceding species, lie along the margin of the arm like the teeth of a saw. In this species, also, about forty pairs of acetabula appear to be metamorphosed as above described.

Of *Loligo Pleii*, D'Orb., from the Antilles, the Museum unfortunately possesses only a single specimen, which has formerly been completely dried; but it is still easy to discern that in this species the transformation commences with the nineteenth pair, and becomes quite as striking as in the two preceding species.

cies, which does not occur in the Mediterranean, and could therefore hardly have been intended by Rondelet as his *L. magna*. It even appears to me on the whole very doubtful whether this was a *Loligo* at all, both when we consider the figure (*e. g.* the long tentacles), and the statement regarding the fins: "pinnulæ latiores sunt quam in Sepia, non totam alvum ambientes, et in angulum acutum in lateribus desinentes," words which are subsequently more exactly explained by the statement regarding the fins of *Sepiola*, as to which he says: "nec figura nec situ pinnis Sepiarum et Loliginum similis, neque enim angusta longaque totam alvum ambit, ut in Sepiis, neque lata et in acutum angulum terminatur, ut in Loliginibus, sed rotunda, parva, utrinque veluti adnata modicam alvi partem occupat, neque ad extremum usque corporis protensa" (p. 250). All this is indicative of *Ommatostrephes*, to which the words "corpore in acutum desinente" are also more suitable than to *Loligo*, even when they are employed in opposition to the body of *Sepia*.

To this, the largest species of our European seas, and also the species upon which I first observed the remarkable metamorphosis of the arm in the male, I have given the name of *Loligo Forbesii*, after Professor Edward Forbes. By this I have wished to keep in remembrance not only that this species is represented in his excellent work above mentioned, but also the services done by this extraordinarily endowed man to natural history in general and to the knowledge of marine animals in particular.

In other species of *Loligo* both series of acetabula at the apex of the arm are not so uniformly subjected to this metamorphosis, but only one series furnishes the above-mentioned papillæ. Amongst the species which I have had the opportunity of examining, this is the case especially in two from the coast of Brazil, namely *L. brasiliensis*, Bl. and *L. brevis*, Bl., together with a species which agrees well with D'Orbigny's description of his *L. gahi*, and which is therefore probably derived from the Pacific Ocean.

Of the last-mentioned species the arm is represented in fig. 3. The left arm is normally constructed as far as the fourteenth acetabulum, after which the peduncles in the outer row of suckers begin to be disproportionately elongated, but still bear small sucking-disks, provided with horny rings, as far as the twenty-second pair, at which the peduncle is quite papilliform, as are all the other peduncles (about twenty-six) which follow it up to the apex; under a strong magnifying power, however, we may still discern a small puncture at the tip of each papilla,—the last indication of the sucking-disk. In the inner row the sucking-disks are continued, with distinct horny rings, nearly to the apex of the arm (at least they may be traced almost to this with a lens), but they are elevated upon peduncles, which constantly rise higher and higher, so that they completely overtop the papillæ of the opposite side. It may also be remarked, that on the inside of each papilla a membranous comb or lobe runs down to the median line of the arm, and thence extends in an oblique direction (for it is well known that the suckers are placed alternately in the two rows) in the form of a similar membranous comb towards the inside of each acetabular peduncle on the opposite side. The development of these membranous lobes commences as early as the fourteenth pair*.

In *Loligo brevis*, Bl., things are essentially the same; the differences appear to me to be that the sucking-disks which persist as far as the apex in the inner series, are not borne upon quite such long peduncles; that the papillæ, which are very long, especially at their commencement, only make their appearance at the twentieth pair; and that the membranous comb is less developed, although always perceptible.

Loligo brasiliensis, Bl., of which the Museum possesses two male specimens from Rio, has both series of acetabula on the left ventral arm regularly developed as far as the fourteenth pair, and the inner row continues essentially in the same way up to the apex (with thirty-five pairs); in the outer series the acetabula diminish rapidly in size, four still exhibiting the sucking-disk

* From their minuteness, no representation of these membranous lobes could be given.

distinctly, and with a slightly developed horny ring; from this point papillæ, which are very low, but tolerably thick at the root, follow to the apex.

In the above-mentioned six species no striking difference exists between the left and right ventral arms below that part of the arm which has entered into this remarkable metamorphosis; but in *Loligo media*, Linn., which is destitute of acetabula on the oral lobes (*Mundfligene*), and which has therefore been raised by Gray to the rank of a distinct genus under the scarcely admissible name of *Teuthis**, this is, on the contrary, the case (fig. 1); the left arm below this part, which in other respects does not differ remarkably from that described in *L. Forbesii* and *L. vulgaris*, being completely armed with very small suckers, whilst the right arm bears large ones. The external sexual distinction between males and females is consequently even greater here than in any of the other species, and we may therefore the more easily settle the dispute between D'Orbigny and Verany with regard to the relation of this species to the *L. Marmoræ* established by the last-mentioned writer. Both in his great work on the Cephalopoda, published in conjunction with Férussac, and in his 'Mollusques vivants et fossiles,' D'Orbigny asserts that the females of our species are the short-finned forms which Verany has called *L. Marmoræ*, and the males, on the other hand, the long-finned forms named *L. subulata* by Lamarck; but this assertion is proved to be quite incorrect by the above-mentioned sexual distinctions, as males and females occur of both these forms, and of all intermediate steps between them. Consequently, I cannot give my adhesion to D'Orbigny's opinion; but neither can I, with Verany, regard these two forms as distinct species, as, in a series of thirteen individuals, I not only find all the intermediate forms, but also a determinate proportion between the prolongation of the abdomen and the fins and the entire bulk of the animal; for which reason I cannot but incline to regard these external differences of form as indications of a more or less complete growth, and therefore the above-mentioned species as forms differing in age.

As the seven species above mentioned represent the genus *Loligo*, not only in all its essential forms, but also in all its different ranges of distribution, I do not think that it can be regarded as an unfounded assumption, that the fourth left arm (ventral arm) will be found metamorphosed in a similar way,

* Gray and Adams, who adduce Aristotle as the authority for the genus (*loc. cit.*), must certainly have forgotten, both that it is difficult, and one might almost say, impossible, at this moment to decide what Aristotle meant by his *Teuthis*, and also that Linnæus has long since applied the generic name of *Teuthis* to a fish.

and furnished with papillæ for a part of its length, in all the species of the genus.

The genus *Sepioteuthis*, Bl., stands so close to *Loligo* in every respect, that, with many naturalists, it can hardly establish its right to subsist as a distinct genus; it was therefore to be expected that it would also approach the species of *Loligo* in the form of the reproductive organs. This, indeed, it appears to do, so far as can be judged from the single species of which I have had the opportunity of examining a great many specimens, namely *Sepioteuthis sepioidea*, Bl., from the Antilles*. As shown by fig. 4, the left ventral arm is actually metamorphosed analogously to that of the *Loligines*, but still with its peculiar character, the peduncles in the outer row of suckers being transformed into compressed leaf-like papillæ, united by a membranous bridge with the roots of the peduncles in the opposite row, which are transformed into blunt elevations. The metamorphosis commences at about the thirtieth sucker, and embraces about twenty-eight pairs of acetabula. It must also be indicated that the right ventral arm of the male *Sepioteuthis* differs remarkably from that of the female, as its extreme third is covered with acetabula so small as to be scarcely visible, and it is therefore to be supposed that in the genus *Sepioteuthis* the right arm assists the left in the part which it has to play.

With the genera *Loligo* and *Sepioteuthis*, which, according to D'Orbigny, form a group by themselves, I associate another genus, established upon two small Cephalopoda, which so strongly resemble certain small *Loligines* (e. g. *L. brevipinna*, Les.) in form, that I should not be surprised if they were nearly allied forms which have been described under this name. They nevertheless form a very characteristic small genus, which, in my opinion, must be placed close to *Loligo*, although it is destitute of one of the characters hitherto regarded as essential to the *Loligo*-group, namely muscular cords on the funnel; and in this respect the species approach the group of *Sepiola* and *Rossia*, as also in the structure of the acetabula, as these have not the small elevated band all round the horny ring, which always occurs in *Loligo* and *Sepioteuthis*. But in all other respects they appear to me to be true *Loligines*. To keep this near relationship in mind, I have formerly named this genus *Loliolus*; this name being a diminutive of "Lolius," from which, according to Gaza, *Loligo* is derived. In both the species of *Loliolus*, the

* Of the other species of the genus, which are all derived from the Indian Ocean and its large gulfs, I have been unable to examine any males. I may take this opportunity to remark, that I have not yet made use of any of the material obtained by the expedition of the 'Galathea' in this investigation.

males of which are represented in figs. 5 & 6, and which are easily distinguished from each other by the different size of the acetabula on the second and third arms, the left ventral arm is also metamorphosed, but in a far higher degree than in the two preceding genera, as throughout its whole length it has not the least trace of a sucker, the surface on which the suckers should be situated being even converted into a compressed, obtusely-toothed edge; we find that all the teeth of this edge are produced from the fused bases of the peduncles of the inner series of acetabula, whilst of those of the other row scarcely the smallest trace is left. Fig. 5′ represents the left ventral arm of *Loliolus typus*, Stp., seen from the outer side, and somewhat enlarged; the small projecting points are the only traces of the suckers and peduncles of the outer series. Fig. 6′ represents the same arm of *Loliolus affinis*, Stp., also magnified; on this I have been quite unable to find any such points, but cannot assert that they are entirely wanting, as the specimen is unfortunately rather flabby. The number of metamorphosed suckers may have been about twenty-six in the former and twenty in the latter, to judge from the number of the teeth*.

With D'Orbigny, as is well known, the genus *Sepia* belongs to quite a different group from the preceding genera; but still, in this genus, it is the same pair of arms which presents the want of symmetry in the male individuals, and the arm of the same side which is metamorphosed, but instead of the apex or apical half of the arm being the seat of the transformation, it is here the basal part or the lower half.

Thus, if we compare the right and left ventral arms in a male *Sepia officinalis*, Linn., we shall see at once, that the lowest fourth part of the left arm (as shown in fig. 7) has a peculiar appearance. Whilst the right arm has large and perfect acetabula, which follow each other in four complete rows, and increase in size from the apex of the arm inwards towards its base, the above-mentioned part of the left arm has only the two or three lowermost suckers in each row normally developed, whilst the seven or eight following suckers in each row have either become

* For the more exact determination of the species, I may also state that both have a broad, free, internal gladius, which has the greatest resemblance in form to those of *Loligo brevis* and *L. brevipinna*, figured by D'Orbigny, tab. 13. fig. 6, and tab. 15. fig. 3. In the species of *Loliolus*, however, the lamina is perhaps rather broader in proportion to the shaft; the shaft has a sharp keel in *L. typus*, whilst both males and females of *L. affinis* have the shaft rather broader, and with a more rounded back. I have no indication of locality for my *Loliolus typus*; *Loliolus affinis* occurred in a glass marked "Captured by Governor Christensen on the voyage from the Cape to Tranquebar," so that it is an inhabitant of the Indian Ocean. There were two specimens, male and female.

very small or almost entirely evanescent. The former is the case with the two innermost rows, in which the acetabula are extremely low, being scarcely one-sixth of the usual height of the suckers, whilst they are still about a third of their diameter, so that they sit like small depressed saucers fixed on a short thin stalk of the inner surface of the arm; the latter, on the contrary, occurs in the two upper rows placed towards the back of the animal, the suckers of which are so small that they may be easily overlooked, when we have not large individuals to examine. On a Cuttle-fish of 11 inches in length they are scarcely more than 0·5 millim. in diameter, and their height is far less. The transformation of the arm, however, does not consist only in the retrogression of these acetabula; this, in reality, only becomes very striking by the coincidence of two other modifications. Thus the arm becomes much broader at the above-mentioned part, not only by the space between the three upper series of acetabula becoming larger, by which these, so extremely small in themselves, being removed to a greater distance apart, must appear even still more inconsiderable, but also by the membranous border, which runs along the outer row of acetabula, and which is rather narrow on the rest of the arm, being considerably developed here, and becoming nearly as broad as the surface of the arm. Then the muscular parts, which, as it were, constitute the roots of the peduncles of the suckers, or from which these peduncles, as it were, originate, have been developed in a peculiar way, becoming elevated, lying like oblique beams across the arm, and partially crossing amongst themselves, by which means a quantity of pits are produced, which are particularly deep towards the upper margin. Lastly, in these pits and on the partitions which separate them, the skin has everywhere folded itself into elevated, thin, membranous laminæ, which run together into a reticulated form, and give the whole surface of this part of the arm a certain resemblance to the inside of a calf's stomach. This pitted and reticulated structure of the surface, which particularly assists the suckers in escaping from the eye, does not confine itself entirely to the true upper surface of the arm, where it is strongest between the two outer rows of suckers, but also extends itself over the corresponding portion of the lateral margin of the arm. It can hardly be doubted that this peculiar structure has for its object a considerable secretion of mucus; but the elucidation of the particular way in which the transference of the seminal mass to the female can thereby be assisted, must be left for future investigations. The tenth or eleventh sucker in each of the four rows makes its appearance suddenly, with its proper size and shape, and from thence to the apex there is no perceptible difference between this arm and that

of the opposite side, or between the arms of the male and female.

In *Sepia inermis*, Van Hasselt, from the Indian Ocean, of which the Museum only possesses one male specimen, and this a small one, of hardly 4 inches in length, I find this peculiarity still more remarkably developed. The lower half of the arm (see Pl. II. fig. 8) possesses no suckers at all, but its whole breadth is metamorphosed in the same way as the outer side of the corresponding portion of the arm in *Sepia officinalis*, a number of pits being arranged distinctly enough in rows by more prominent folds of skin, which pass transversely across the arm. The strongest transverse folds appear to indicate the position of the muscular parts, to which the peduncles of the acetabula are attached; and from their number, we may suppose that about twenty transverse rows of suckers have disappeared. Both margins of the arm have a tendency to fold together, and thus, as it were, to form a very long sucking or grasping plate. The specimen referred to, from which fig. 8 is drawn, was unfortunately somewhat flabby, and not very well preserved; a better-preserved specimen may perhaps exhibit a trace of the suckers, the existence of which I have thought myself compelled to deny. At any rate, this structure, in an Indian species of *Sepia*, renders it probable that the peculiarities above described in *Sepia officinalis* do not occur in this species alone, but that we have in this case to do with a phænomenon occurring in the whole genus *Sepia*.

Of three other species of this genus I only possess female specimens; and in these, as in the females of the two preceding species, the four series of suckers pass up to the base of the arm, constantly increasing in size.

With the genus *Sepia*, D'Orbigny groups the two principal genera of the small shore Cuttle-fish,—*Sepiola*, Leach, and *Rossia*, Owen; but, as regards the peculiarities of the arms, which we are investigating here, they are widely separated from each other, as the following will show at once.

In a male *Sepiola Rondeletii*, D'Orb., I found the following peculiarities. Of the first, or dorsal pair of arms, that of the right side bore very small suckers in two rows up to the apex; and these, which became smaller quite regularly upwards, did not attain one-fourth of the size of the large globular acetabula which are found on the second and fourth pairs of arms, especially on their middle portion; in this they agreed with the suckers of the third pair. In this unequal development of the acetabula this male *Sepiola* of mine also agrees with fig. 5 of the first plate of *Sepiola* in the great work of Férussac and D'Orbigny. The arm on the left side, however, differed not only

from that opposite to it, but also from all the other arms of the animal, as it was, so to speak, inflated in a peculiar way through its whole length, as shown in my fig. 9. On a closer examination, it appeared that the cause of this inflated state was, that the otherwise spherical peduncles of the suckers had become much elongated and cylindrical, and amalgamated together; with the obtuse apices of these cylinders, the suckers are united by such thin and short filaments, that they almost appear as if they were sessile; their diameter is the same as that of their cylinders, so that they nearly touch each other with their outer margins. This applies especially to the inner row of suckers, which exceed those of the outer row in size, and project beyond them, as is shown more distinctly by fig. 9″, which represents this arm seen from the ventral side, and fig. 9‴, which exhibits two of the suckers in both rows more strongly magnified. The first-mentioned figure also shows a remarkable dilatation of the skin developed at the base of the inner surface of the arm, strongly provided with muscles, and thus rendered capable of dilating itself towards the sides and folding itself together, so that it appears able to act as a prehensile apparatus or forceps. It is here represented with the margins rolled together in the nozzle-like form which it had in the spirit specimen. Below this nozzle (*Dille*) there are seated four small suckers of the size and form of those situated at the base of the other arms, from which we see that this dilatation of the skin occupies the same position on the arm as the dilatation on the arm of the *Sepiæ*; and that this apparatus has essentially the same import as the above-described part in the genus *Sepia*, I cannot doubt. I have already mentioned that fig. 5 on the first plate in Férussac and D'Orbigny best represents my male *Sepiola* as regards the general habit and the strong spherical acetabula on the second and fourth pairs of arms. I will now request that this figure may be compared with mine in regard to the structure of the left dorsal arm, and it will certainly be admitted that it is probable that the peculiar form which this arm has received in the figure must be founded upon such a structure as that which I have here described. As all my females had small suckers where the male possessed the large ones, and had the right and left dorsal arms equally developed, so as to correspond with the other figures which D'Orbigny has given of the species, I naturally regard the often-mentioned fig. 5 as representing a *male*, and not an individual with a morbid or monstrous development, as D'Orbigny explains this figure of his*. I also possess another male *Sepiola*

* At p. 237 of his continuation of Férussac's great work on the Cephalopoda (Histoire naturelle et particulière des Mollusques), D'Orbigny says of *Sepiola atlantica*:—"Cette espèce, de même que la *Sepiola Rondeletii*,

from the Mediterranean, which belongs to the same group as *S. Rondeletii*, as it has only two rows of acetabula on each arm; its second and fourth arms also bear large and spherical suckers, and its left dorsal arm is metamorphosed in an exactly analogous manner with that of the preceding, from which, however, it is distinguished by the suckers being larger in proportion at the lower part of this arm, and diminishing more suddenly towards the end of the arm; they are at the same time rather more pedunculate, and the basal parts of these peduncles are not so strongly amalgamated. The peculiar prehensile part at the root is also less developed.

In the genus *Rossia*, so nearly allied to *Sepiola*, it was to be expected that the behaviour of the arm would be the same. I find that this is actually the case as regards the *pair* to which the metamorphosed arm belongs, but the metamorphosis itself is very different. Unfortunately I possess no male of the true European species, but, on the other hand, I have examined five male individuals of the genus *Rossia* from the coast of Greenland. These five individuals decidedly belong to two different species, but they all agree with each other, and differ from the female individuals, both of the European and Greenland species, which I have been able to examine, in that the three lower pairs of arms, the second, third and fourth pairs, bear considerably larger suckers than the first pair, or the dorsal arms, whilst in the females this pair does not bear perceptibly smaller suckers than the rest; and also that the same first pair, *the right and left arms*, has the outer row of these suckers, for nearly two-thirds of the length of the arm, standing upon high peduncles, the roots of which are uncommonly strongly developed, compressed, and, in the soft state, almost leaf-like; between these peculiar peduncles we see folds of skin insert themselves, and other similar folds of skin issue from the roots of the peduncles. (Pl. III. fig. 1.) These remarkable folds of skin, on closer examination, prove to be only luxuriant developments of the ridges of skin which in the *Rossiæ* surround the base or the peduncle of the individual acetabula like cups, as is the case also partially in *Sepiola*,—cutaneous formations to which sufficient attention has perhaps not been paid hitherto, but which possibly correspond

est assez sujette à une maladie qui consiste en une durcissement et une croissance beaucoup plus grande des cupules des bras sessiles, qui deviennent quatre fois aussi gros que les autres, sans que leur cercle corné suive la même proportion. Cette affection allonge les bras, les fait gonfler, ou les rend souvent difformes." Of *Sepiola Rondeletii*, also, he says, in the explanation of figures, p. 233, and indeed with reference to the very figures (5 & 6) which I have mentioned above as unmistakeably resembling my figure:—"Fig. 5, Individu malade; ses cupules devenues plus grosses et plus durs. Fig. 6, Portion de bras affecté de la maladie indiquée."

with those which D'Orbigny has described after Tilesius in *Sepiola japonica*, Til. About eleven acetabula are thus strongly elevated on the outer side of the right and left arms, whilst the remaining suckers are borne upon lower peduncles, which, however, agree essentially with the others. As the so-called "covering membrane" (*Deckhaut*) of the acetabula, which I have called the lateral border of the arm in the preceding, is very strong and broad on the outer side of the arm *before* these eleven suckers, and the above-mentioned folds of skin are continued upon it, some similarity is produced between this development and that which we met with in *Sepia*, just as we have here the metamorphosis in the lower part of the arm, or principally in it. Lastly, it must also be observed, that in all the five individuals both arms are so obliquely twisted inwards, that it is evident a co-operation between the outer side of both arms is facilitated thereby. These two species are probably amongst the largest in the genus, as they are of equal size with *R. palpebrosa*, Owen, with which one must, in my opinion, be identical*, but there is scarcely sufficient reason for supposing that the smaller species would not exhibit peculiarities agreeing with these†.

* The two species are easily distinguished from each other, as one has extremely small suckers on the clubs of the tentacles, as is the case, according to Owen's description and figure, in *Rossia palpebrosa* ♀, whilst both males and females of the other species have very large suckers on the clubs; the middle row of these considerably exceeds the large spherical suckers of the arms in size, by which peculiarity this species also differs notably from all other described species. To this remarkable form I have given the name of *Rossia Mölleri*, Stp., after our late countryman, H. C. Möller, who has done such service to the Molluscan fauna of Greenland. The two dorsal arms, Pl. III. fig. 1, are drawn from the male of this *R. Mölleri*.

Induced by this and several other additions to the fauna of Greenland, which will be referred to in this memoir, I seize the opportunity of reminding the reader, that both the original collection which served Möller as the foundation for his "Index Molluscorum Grœnlandiæ," and also his subsequent collections for a more complete elaboration of this work, have been presented to the Zoological Museum of the University by his father, and that an enlarged and more complete edition of Möller's Index, with original figures, is being prepared by M. O. Mörch, principally with the aid of the above-mentioned material.

† I make this remark with reference to a peculiarity in the remarkable *Rossia dispar*, Rüpp., noticed incidentally in Verany's work on the Cephalopoda of the Mediterranean. In this small species, which was first recognized by its disproportionately large suckers on the uppermost lateral arms (see Verany, *l. c.* tab. 23 *d*, *f*, *g*, *h*), for which Gray also has formed a separate genus under the name of *Heteroteuthis*, according to a letter to the author from Dr. Krohn, all the individuals furnished with these large suckers have proved to be females; whilst of another form, agreeing with this in other respects, but destitute of the large acetabula, and for which the name of *Rossia affinis* was thought of, only males have been met with.

The genus *Ommatostrephes*, D'Orb., formed of those species of the older genus *Loligo*, in which the eyes are uncovered by the general integument, and the structure differs in many other respects from that of the species of *Loligo* in the narrower sense; the genus *Onychoteuthis*, Lichtst., with its subgenus *Gonatus*, Gray; and the genus *Loligopsis* as it was peculiarly understood by Férussac and D'Orbigny, which does not appear to stand in connexion with the Cephalopoda upon which Lamarck originally founded his genus *Loligopsis*,—do not present the same differences in the structure of a single pair of arms in the male individuals. Nevertheless, important external differences between the males and females are not wanting, as appears even from Verany's description and figure of the two sexes of *Omm. sagittatus*, Lamk., and as I can confirm from the examination of both sexes from the Mediterranean. It is, however, not only the comparatively much shorter body and the much longer and stronger arms which distinguish the males from the females, but there is also the remarkable difference, which Verany has overlooked, that in the male both the lateral arms bear suckers several times larger than those of the ventral and dorsal arms, whilst in the females the suckers of the lateral arms do not greatly exceed these in size. In these forms, therefore, I by no means doubt the existence of external sexual distinctions, but only that of a less symmetrical development of one of the pairs of arms with reference to reproduction. In connexion with this, however, I must expressly observe, that although I have had the opportunity of seeing a considerable number of species,—and namely no less than six* of the so-called "*Loligopsides*," which as a group I

Under the supposition that this observation is correct (?), it remains a question whether these males do not exhibit the dorsal pair, in the first place, with smaller suckers than the other three pairs of arms, and in the second, analogous to the arms in the above-mentioned three species. It requires a closer investigation to determine whether the two *Rossiæ* from the Irish coast, described by Ball, *R. Owenii* and *R. Jacobii*, of which the latter is referred to *R. macrosoma* by Forbes and Hanley, are not in the relation to each other of males and females of the same species; at least the former agrees, in the characters of the suckers, with my males, and the latter with my females. See the figures of these two species in Forbes and Hanley, plates N. N. N. and S. S. S.

* As this group still contains so few species in the system, and as these Cuttle-fishes are very rare in general in museums, it will hardly be superfluous to refer to this number. The six species above mentioned are all Atlantic; two of them are very small species of the genus *Chiroteuthis*, D'Orbigny, with much resemblance to the *Lol. zygæna*, Ver., described in Verany's work, and figured on pl. 40, and to *Lol. vermicularis*, Rüpp.; two others are also small species, but belong to the genus *Leachia*, Les., one of which is the *Cranchia* (*Owenia*) *megalops*, described by Prosch in the Memoirs of this Society; and a second remarkable species, to which I have given the name of *L. Reinhardtii*, and which is distinguished from all

would prefer naming *Hyaloteuthiæ* or *Medusoteuthiæ*; of the *Onychoteuthis* group, two, and of the genus *Ommatostrephes*, five species,—yet I have only had a considerable number of individuals of each sex for examination in very few species, namely in one of each of the last-mentioned genera; so that it is not impossible that an observer more fortunately situated in this respect, and especially one residing on the Mediterranean, might ascertain what I have been unable to discover. In this case, however, the metamorphosis will certainly be confined to an extremely small part of the arm*.

From the remarkable forms which, as we have seen, are acquired by a particular arm in most of the male Cephalopoda of the order *Decapoda*, this being peculiarly developed for a particular object, let us now turn to the *Octopoda*. If we have been unable to repress the feeling that this remarkable development very closely represents the Hectocotylus-formation in the genera *Argonauta* and *Tremoctopus* among the latter, it is natural that we should seek to discover a trace of the same formation in the other genera of the Octopod Cephalopoda, in order, in this way, by closer transitions, to give greater probability to this idea.

When we investigate the series of the species of the genus *Octopus* itself, and at the same time compare their external structure, we find that the arm, which is "hectocotylized" in the two genera above mentioned—which, as is well known, is the

the previously described species by its strong armature of cartilaginous bands on the mantle. Besides a toothed cartilaginous band down the median line of the back, it has on each side of the body two other toothed cartilaginous bands or ribs, which meet at an acute angle exactly at the points where the mantle is united with the funnel on each side; the proportions of the arms are 3, 2, 4, 1, and they only bear two series of suckers; the tentacles have four rows of suckers on the outer third, which are continued in a scattered arrangement over the middle third; the fins are terminal, small and roundish. Lastly, I have a large and very important species of the same genus from North Greenland, *Leachia hyperborea*, Stp., which is distinguished from *L. pavo*, Les., with which it appears to be most nearly allied, by the length of the fins, which are very narrow, follow the sides of the body for half their length, and together form a lanceolate figure; by the different comparative lengths of the arms, which are 3, 2, 1, 4; and by the considerable size of the acetabula and the shortness of the tentacles, which are only twice as long as the true arms. These new species, with several other Cuttle-fishes of the Atlantic, are destined to form the subject of a future memoir. The sixth species is an imperfect *Histioteuthis*, D'Orb.

* In my two male *Ommatostrephes*, Lamk., one of the ventral arms does, indeed, exhibit a peculiar form at the apex, which might indicate such a metamorphosis; but as in one individual it is the left and in the other the right arm, and as both appear to have been slightly injured at this place during life, I could not regard this as normal, especially as I could find nothing similar in male *Ommatostrephes* of other species.

third arm on the right (*Tremoctopus*) or left (*Argonauta*) side of the animal,—is also formed differently to the other arms in the genus *Octopus*, and in this case it is always the arm on the right side which has become transformed. This arm is always shorter than the left one, even to a considerable extent, as its length in different species is only one-half to three-fourths of that of the latter; and as, besides this, it not only often retains the same thickness, but is even more muscular in its outer half, it has frequently a more powerful appearance. It bears far fewer acetabula than the left arm, and is furnished externally at the apex with a peculiar, usually longish plate, which is provided, in most species, with a greater or less number of transverse wrinkles or ribs with intervening pits. This plate is also connected with the swimming-membrane at the base of the arm by the agency of a muscular border of skin, which runs down along the dorsal margin of the arm, and this border is very often found with its free margin rolled up towards the inner side of the arm, by which a more or less closed canal is formed, which is undoubtedly destined to conduct the spermatophora to the apical plate of the arm. As this canal or semicanal is destitute of chromatophora on the inside, and perfectly white in most species, I conclude that in the living animal this membranous margin will in general be bent towards the side of the arm, as was seen in most of the spirit specimens.

This is the case at least in *Octopus grœnlandicus*, Dewhurst (= *O. arcticus*, Prosch), in five males of which I find only 41–43 acetabula on the right arm of the third pair (whilst on the corresponding left arm I find 74–79), a spoon-shaped prehensile plate furnished with 13–17 transverse ribs at its apex, and a cutaneous margin which extends from the latter to the middle of the connecting membrane between the third and fourth arms, where the semicanal or groove, formed by this margin, also suddenly ceases. Fig. 2, on Pl. III., which is of the natural size, is intended to assist the comprehension of this peculiarity: *a* is the grasping-plate, as I have called it, separated from the sucker-bearing part of the arm by a high angular fold of skin (*d*); *b*, *b* is the membranous border; and *c*, the place where it commences or terminates at the margin of the swimming-membrane*. In one specimen, a seminal capsule or spermatophore projected from the funnel, and was probably on the way towards this membranous border, to which it is most likely conveyed by the upper extremity of the funnel simply laying itself against the commencement of the fold of skin.

* The sucking-disks on all the true arms are of about the same size; their appearing larger on the first pair in the figure is owing to the direction in which they were seen by the artist.

In a male specimen of *Octopus macropus*, Risso, or *O. Cuvieri*, D'Orb., collected by Professor Eschricht near Cette, and now handed over to the Zoological Museum of the University, I find the characters so far in agreement with those of *O. Grœnlandicus*, that here also the right arm of the third pair is much shorter than the left one,—the former being not quite 10 inches, whilst the latter is nearly 20 inches in length; and the right arm is at the same time dilated at the apex into a muscular plate of 13 mill. in length, but narrow, which bears no suckers, and is separated from the sucker-bearing part of the arm by an elevated fold. Although the specimen was somewhat flaccid, a tendency of the margins of the terminal plate to bend together like a grasping apparatus was recognized; but no transverse elevations were to be seen, perhaps only in consequence of the above-mentioned state of preservation. Below this grasping-plate the arm was of the regular construction, with the exception of its stronger muscularity and greater thickness, and the muscular border down the side of the arm.

Another species of *Octopus*, also a native of the Mediterranean, but which I can by no means regard as a small *O. vulgaris*, exhibits essentially the same character: the arm is represented of half the natural size, with the border unfolded, in Plate III. fig. 3. The number of transverse ribs in the grasping-plate is 17.

Besides several species of *Octopus*, the determination of which I have found impossible from the want of materials for comparison, I have also examined several male individuals of *O. rugosus*, Bosc, from the West Indies, likewise a great number of males of *O. vulgaris*, Lamk., from the Mediterranean, and a male *Octopus* from the coast of Chili, which, from the considerable size of some particular pairs of suckers on the lateral arms, appears to be the well-known *O. Fontanianus*, D'Orb., of that coast. In all of these I have found that this right arm has a muscular fold of skin along its inner or lower side, destined to form a canal or semicanal for the passage of spermatophora, and that it is furnished at the extremity with a small sucker-like dilatation, which, however, is so inconsiderable that it may easily escape observation, whilst the arm itself is sufficiently distinguished from the opposite one by the above-mentioned rolled-up fold of skin, and by its abbreviation, although it is not thicker, as in the other forms, but appears thinner and more pointed in its outer half than the other arms. I must therefore assume, that in all species of *Octopus*, without exception, this third arm on the right side is destined for the conveyance of spermatophora.

I must add, particularly, with regard to *Octopus vulgaris*, Lamk., that five uncommonly large male individuals examined by me all have the fourteenth, fifteenth, or sixteenth sucker on

their lateral arms, of a very disproportionate size, and that the uppermost pair of these lateral arms also usually had the suckers in the neighbourhood of this large sucker of nearly the same size, whilst in only one of these specimens there was a tendency to develope two such sucking-disks on the lowest lateral pair, or the so-called third pair of arms. At the same time the third right arm was about a foot shorter than the left one, but also distinctly thinner in its outer half, and it had the pointed terminal surface at the extremity; the fold of skin, which is very white on the surface turned inwards, gives the arm an appearance as if the side of the arm were divided into two parts by a longitudinal cleft*. In no female, although even here the

* The characters which I have here indicated, namely the pointed form of the arm, the strong cutaneous fold along the dorsal part of the arm, the distinct white colour of the inside of this fold, its rolling towards the side of the arm, from which it only appears to be separated by a deep crack or furrow, and indeed from the very apex, and lastly, the above-mentioned large sucking-disks on the two lateral pairs of arms, and even on the arm which assists in reproduction, enable us to understand three passages in Aristotle, which have not hitherto been perfectly intelligible to philologists and zoologists. These passages show us, that in the common *Octopus* of the Mediterranean, his *Polypus*, Aristotle not only knew of this peculiar form in the one arm, but was also aware that it stood in connexion with reproduction, although he distinctly asserted that the semen was not conducted through the arm.

In one place, Aristotle says very briefly, regarding his *Polypus*: Διαφέρει δὲ ὁ ἄῤῥην τῆς θηλείας τῷ τε τὴν κεφαλὴν ἔχειν προμηκεστέραν, καὶ τὸ καλούμενον ὑπὸ τῶν ἁλιέων αἰδοῖον ἐν τῇ πλεκτάνῃ λευκόν (lib. v. c. 10. 1, edit. Schneider, p. 196), which must be translated: "differt mas a fœmina eo, quod habet caput (*i. e.* abdomen) oblongius, et *genitale*, quod a piscatoribus vocatur, *in brachio album.*" This expression refers, in the first place, to that employed in another passage in the same book (lib. v. c. 6. 1. p. 188), wherein it is stated more in detail—Φασί δέ τινες καὶ τὸν ἄῤῥενα ἔχειν αἰδοιῶδές τι ἐν μιᾷ τῶν πλεκτανῶν, ἐν ᾗ δύο αἱ μέγισται κοτυληδόνες εἰσίν· εἶναι δὲ τὸ τοιοῦτον ὥσπερ νευρῶδες μέχρι εἰς μέσην τὴν πλεκτάνην προσπεφυκὸς, ἅπαν τε (εἰσαφιέναι) εἰς τὸν μυκτῆρα θηλείας—that is to say, "aiunt nonnulli, marem in uno brachiorum, in quo sunt duo maxima acetabula, quoddam genitali simile habere, idem esse quasi nervosum, usque ad medium brachium adnatum, et totum in narem (fistulam) fœminæ inseri." It also refers, as we now certainly find, to the more exact description of the arm in the fourth book: Ὁ μὲν οὖν πολύπους καὶ ὡς ποσὶ καὶ ὡς χερσὶ χρῆται ταῖς πλεκτάναις· προσάγεται δὲ ταῖς δυσὶ ταῖς ὑπὲρ τοῦ στόματος, τῇ δ' ἐσχάτῃ τῶν πλεκτανῶν, ᾗ ἐστιν ὀξυτάτη τε καὶ μόνη παράλευκος αὐτῶν καὶ ἐξ ἄκρου δικρόα (ἔστι δὲ αὕτη ἐπὶ τῇ ῥάχει· καλεῖται δὲ ῥάχις τὸ λεῖον, οὗ πρόσω αἱ κοτυληδόνες εἰσί·) ταύτῃ δὲ τῇ πλεκτάνῃ χρῆται ἐν ταῖς ὀχείαις (lib. iv. 1. 6. p. 131)—that is, "polypus vero brachiis et ut pedibus et ut manibus utitur, nam duobus, quæ supra os habet, admovet ori cibum, extremo autem brachiorum, quod est acutissimum et solum eorum ex parte candidum et cui ab apice fissura (est autem hæc in spina: spina vero vocatur pars lævis brachii, e cujus latere anteriore acetabula sunt)—hoc brachio in coitu utitur."

That in the above words Aristotle referred to such a formation as I have

lateral arms were unmistakeably the largest, did I find such large suckers.

This equipment of the males of *Octopus vulgaris* with isolated suckers of remarkable size on certain arms, induces me not to quit the genus *Octopus* without calling attention to the fact that the above-mentioned *O. Fontanianus*, D'Orb., which, according to D'Orbigny, is the only species hitherto observed on the coast

described above in *Octopus*, and especially in *O. vulgaris*, hardly requires to be more exactly indicated, and it is nothing but a want of acquaintance therewith that has led naturalists astray, when they have asserted that Aristotle had some knowledge of the remarkable peculiarities discovered within the last few years in *Argonauta* and *Tremoctopus* (see Von Siebold, Zeitschr. für wiss. Zool. 1853, p. 122–124; Roulin, Ann. Sc. Nat. 1852, xvii. p. 191; Owen, Lectures on Comp. Anat. 1855, p. 634†). Aristotle's sources of information were evidently the fishermen of the Mediterranean; these perhaps still know the mode of reproduction of the Octopods, although it is certainly very remarkable that the naturalists who have occupied themselves so much with the Cuttle-fishes of the Mediterranean, especially of late years, should have learnt nothing about it. Pliny appears to me only to have known the traditions of the celebrated Greek philosopher and naturalist; he calls the arms of the Cephalopoda, pediculi, cirri, crines, brachia, and has the following passage regarding their employment in the service of reproduction in the *Polypus* or *Octopus*: "Omnes brachiis, ut pedibus ac manibus, utuntur; cauda vero, quæ est bisulca et acuta, in coitu" (lib. ix. 46); and "polypi (coeunt) crine uno fœminæ naribus annexo" (lib. x. 74).

Rondelet, with whom, as with his contemporary, Gesner, Aristotle is a principal source of information, and with whom the interpretation of the Greek text is an important matter, expresses himself as follows upon the above-mentioned statements of Aristotle: "Sed hæc somnia esse, anatome certo demonstrat. Mihi sæpius polypos dissecanti nunquam visa sunt acetabula ista majora in uno brachio quam in alio, præterquam in primo et maximo polyporum genere, *in quo non duo in uno brachio sed quatuor in quatuor brachiis acetabula præ ceteris omnibus maxima comperias*, in aliis generibus minima. Quod si semen hac emitteretur, necesse foret, meatum aliquem ab internis partibus huc deductum, fœminam quoque eodem meatu semen excipere ovaque edere, quæ fieri non posse, fatebuntur omnes qui polypos viderunt, et ovorum in inferiori alvi loco situs necessario convincit, alio quam brachii acetabulo ova edi." (De Piscibus, Lugduni, 1554, lib. xvii. pp. 511, 512.) Rondelet has therefore correctly observed the four large suckers on the lateral arms of the male, but we cannot exactly see whether he has regarded them as a sexual character; in this respect, however, he is somewhat in advance of the more modern observers, who have overlooked both these and the *brachius copulator*. In D'Orbigny I find no observations upon this organ; Verany has regarded the large size of the suckers as something accidental, stating, correctly enough, that "the suckers increase imperceptibly up to the fifteenth, which is usually the largest," but afterwards adding, "and often very disproportionate to those which touch it, especially on the arms of the third pair." (*l. c.* p. 17.)

† The author last cited states (p. 634), "It would seem, also, that the modified arm of the male in certain Octopods had not escaped the notice" of Aristotle: citing the passage in question.

of Chili, and which is principally distinguished from the other species of *Octopus* by the character which I have found to occur, and indeed in a remarkable degree, in all male individuals of our commonest species, is probably established only upon males, and is perhaps also a collective species, consisting of males of several distinct species. At all events, two male Octopods from the coast of Chili which I possess, present, together with the common character of these large suckers on a particular part of the arm, such great differences, that they can hardly be regarded as belonging to a natural species: one of them, a very large specimen, of the size of an ordinary *O. vulgaris*, has 90 pairs of suckers on the third right arm; the other, which was brought from Valparaiso by Professor Kroyer, is much smaller, and has only 40 pairs of suckers on the same arm; the large one has the terminal plate but slightly developed, whilst the hectocotylized arm of the smaller specimen bears an elongated, lanceolate, terminal plate with faint transverse wrinkles, and the angle of the fold of skin previously mentioned is drawn out into a papilliform point (fig. 4); the small male also has the isolated, disproportionately large suckers on the dorsal and ventral as well as on the lateral arms, and the latter are not thicker than the uppermost and lowest pairs, whilst the large male has these large suckers only on the lateral arms, which preponderate considerably over the other arms. Now, as I am also in possession of a female Cephalopod which approaches the smaller male, but is destitute of those suckers, I believe I am justified in expressing my above-mentioned suspicion against *O. Fontanianus*; but I must reserve myself for a final decision by more abundant material. At present I must advise naturalists to be cautious about admitting the whole group of Octopods which Gray wishes to bring together by a character which at least partially coincides with the most essential specific character hitherto given for *O. Fontanianus*; according to Gray, the males of *Octopus vulgaris* would come in this, his third group, whilst the females would remain in his first*.

A male individual of the genus *Eledone*, Leach, which is derived from the Mediterranean, and which, as it has a cirrus over the eye, would most probably be the common *E. moschata*, Leach, shows that this nearly allied genus possesses a similar structure of the arms, as is shown more exactly in Pl. III. fig. 5. As in the genus *Octopus*, the third right arm is shorter and somewhat stronger than the left one; it bears only 64 acetabula, whilst

* Gray, Catalogue of the Mollusca in the Collection of the British Museum, Part 1. London, 1849, p. 14. With regard to the *O. oculatus*, D'Orb., which also stands in Gray's third group, I can at least certify that only the males possess the very large sucker on the lateral arms.

the opposite one has 93, so that the deficiency is about one-third. A strong cutaneous border commences in the middle of the margin of the membrane stretched between the third and fourth arms, and thence runs along the arm to its apex, where there is a peculiarly developed terminal portion, destitute of suckers, which evidently represents the spoon-shaped plate of the Octopods, but which is furnished with several elevated longitudinal folds. The individual figured also deserves notice, because the seven other arms are not provided with acetabula at the extremities, but with two rows of cutaneous laminæ, a peculiarity which I do not find described in any *Eledone*, and which therefore made me doubt for some time whether I had not a new and undescribed species before me. As, however, two male specimens* afterwards examined, of which one at all events was from the Mediterranean, were also destitute of acetabula at the apex of the arms, and bore similar laminæ in their place, whilst I could not find the least trace of anything of the kind in numerous females of *Eledone* from the Mediterranean, I assume that this peculiar development of the extremities of the arms only occurs in the males, so that it is a sexual character (see fig. 5″).

In this opinion I am the more strengthened as I find exactly corresponding cutaneous formations at the extreme ends of the arms in a large male *Eledone* from Bergen, which is certainly *E. cirrosa*, Lamk., whilst several females, partly from the same locality, and partly from other places on the Norwegian coast and from Faerö, exhibit no trace of it. Nevertheless, in the last-mentioned species these cutaneous lobes differ from those occurring in *E. moschata*, in being less foliaceous or plate-like, but more elongated and thin, almost like cirri or filaments. Fig. 6 represents a small portion of them from one of the arms, but certainly from a specimen which was in a rather flabby state.

In opposition to the great uncertainty which prevails in this genus in the recognition of the species in consequence of the want of definite external characters†, these observations upon the different development of the apices of the arms in the two sexes and in different species, may conduct us to the right way, when they are extended to all described species.

* In these individuals the third right arm had respectively 62 and 65 developed acetabula.

† A want which is so great, that the species which have been regarded as far removed from each other, are essentially distinguished, in that some have a cirrus over the eye, the others not (although this cirrus appears always to be more or less distinctly present), whilst the more nearly related species are not to be distinguished even from spirit specimens. See Verany, Mollusques Méditerranéens, p. 15 : "car, je l'ai déjà dit, après la mort les deux espèces sont, si je peux m'exprimer ainsi, indéchiffrables."

Guided by this remarkable form and metamorphosis, in the males of *Octopus* and *Eledone*, of exactly the same arm which, in the male individuals of the genera *Argonauta* and *Tremoctopus*, becomes developed into a separable and deciduous transferer of semen, and by the unmistakeable concordance which occurs again between the development of the arm in *Octopus* and *Eledone*, and the peculiarity which I have above described in the male Decapoda*, I no longer regard it as doubtful that all these developments belong to one category, and all have essentially the same object, namely the transference of the spermatophora, or of the seminal masses contained in these peculiar capsules, to the female, or perhaps to the eggs. Nor do I doubt that, provided this supposition be correct, the peculiar transitions presented by each genus have their determinate purpose, and give rise to many different modes of fecundation; but what the details of these may be, must be left to be decided by observations on the animals in a state of nature. For the guidance of subsequent investigators, I shall take leave at a future meeting of the Society to bring forward the indications which have been furnished to me by spirit specimens, as in these we certainly see that the transfer of the spermatophora takes place in very different ways, and that the actual fecundation of the ova must be effected in many cases in an unexpected and very remarkable fashion.

Before passing to some general remarks to which these observations lead, I shall give an exact description of a very perfect *Hectocotylus*, or of an arm which is destined not merely to transfer the semen, but also to become detached and to fasten itself with the entire mass of semen upon the female; and I do this the rather, as hitherto the formation of *Hectocotyli* is only known in the larger species of *Tremoctopus* (*T. violaceus* and *T. Carenæ*) which live in deep water, but not in the smaller oceanic species of the genus living nearer the surface, for which we may perhaps provisionally retain D'Orbigny's name of *Philonexis*; and it is exactly one of these small oceanic species, namely *P. Quoyanus*, D'Orb.†, of which I have had the opportunity of examining the *Hectocotylus*.

In *Philonexis Quoyanus* the development of the *Hectocotylus* differs from the well-known process in *T. Carenæ*, in that it is not formed in a pedunculated membranous bladder, but in a

* In one of my males of *Rossia* I found two soft envelopes of seminal capsules between the cutaneous folds of the arm.

† Should it turn out hereafter that *P. semipalmatus*, Owen, is not synonymous with D'Orbigny's species, my species will probably be nearest to *semipalmatus*, according to Owen's figures. A male was captured with three females, by Professor Reinhardt, under 22° 4′ N. lat. and 24° 40′ W. long.

large and spacious cutaneous sac, which lies deeper than the root of the arm, and occupies essentially the same place as the large folds in the genera *Sepia*, *Rossia*, &c., into which the tentacles may be more or less retracted and received. Figure 7, which represents a male specimen of this species three times the natural size, shows at once that the male has only seven arms, which are all regularly developed, and that the absent arm is actually the right arm of the third pair. On closer examination, however, it is seen that the place where this right arm should be situated is as it were swelled up, and that by this swelling both the fourth pair of arms and the funnel are not a little displaced towards the left side. Under a lens it is easy to perceive that the cause of this displacement is a very long, rolled-up arm, which occupies the space between the funnel, the eye, and the root of the arm, and which is covered only by a skin so thin and transparent, that the eye may easily trace the curves of the arm, and distinguish their finely fringed margins and the individual acetabula which are turned towards the skin, which, however, in consequence of the mode in which the arm is rolled up, are but very few. In the enveloping membrane I have been unable with the lens to detect either an actual opening through which the arm might issue forth, or a line or impression, to indicate where a division might subsequently occur, as is known to be the case in *T. Carenæ*; but perhaps this would have been more distinct on the fresh specimen. After opening the cutaneous sac by an incision with a sharp knife, it was easy to draw forth the remarkable *Hectocotylus*-arm. This is represented, when thus extracted, in fig. 8. It was quite colourless throughout its whole extent, like the previously observed *Hectocotyli* of *Argonauta* and *Tremoctopus*, but individual chromatophora existed in the membrane covering it. Its length is several times that of the corresponding arm on the opposite side of the animal, although this is longer than the very long first and second pairs (by which, indeed, this species is characterized), and bears no less than 33 pairs of acetabula; therefore a greater number than is supported by any of the other arms. These acetabula are of nearly equal size throughout the entire length of the arm, and the arm itself is also nearly uniform in breadth throughout. At the apex the arm swells into a nearly pyriform part, which is destitute of suckers; and along one side of this swelling there is a slight furrow and fold of skin, of which the latter appears to be traceable down the arm for a short distance. At the base of the swelling and close to the extreme sucker of the arm, is the origin of a long lash or filament of 55 mill. in length, the basal portion of which appears as if surrounded by a thin sheath. It is still to be re-

marked, that along each lateral margin this *Hectocotylus* bears fine cutaneous papillæ in a longitudinal furrow; these papillæ, which are placed close together, and stand here and there in several close series, gave the fringed margin to the arm in its coiled-up state, and they must also be what were regarded as branchiæ when the *Hectocotylus* was considered to be an independent male organism. In this specimen I was unable to find any trace of a dorsal cavity with an external orifice; but this would be formed essentially by the covering membrane when the arm was naturally and spontaneously rolled up,—a mode of development which presents no difficulty for the species hitherto observed, but of which it is difficult to form a clear notion here, on account of the form and position of the enveloping sac. In reference to this it must be mentioned, that the only known *Hectocotylus* which resembles my form in the want of the dorsal cavity and the presence of "branchiæ," is that found and described by Kölliker on the female of *Tremoctopus violaceus*, the development of which, however, is still unknown, as the males of this Cephalopod have not yet been discovered*.

It seems probable to me, that the vesicular or pyriform, swelled, terminal portion of the *Hectocotylus* represents the apical plate in *Octopus* and *Eledone*, which has already been repeatedly mentioned, and also that the long filament or "flagellum," which occurs in all *Hectocotyli*, and originates in all at the same spot, namely where the angle of the fold of skin described in *Octopus* and *Eledone* is situated, may be the apex of this angle which has been more developed and elongated (see fig. 4 *d*); only then it cannot be an axial portion. It also appears probable to me, that the muscular membranous border which forms the above-described furrow or semicanal in the hectocotylized arm in *Octopus* and *Eledone*, which, however, is only a peculiar development of the membrane which runs for a greater or less distance along the arms in all Cephalopoda, may be exactly the same membrane which, in *Argonauta* and *Tremoctopus Carenæ*, envelopes the entire *Hectocotylus* in its rolled-up state, and which, when the arm is subsequently stripped off, according to the observations of Verany and Vogt, at the same time forms a dorsal cavity at the base of the arm; whilst, as regards its import, this furrow rather corresponds with the internal canal on the dorsal surface of the *Hectocotylus*, which is destined for the re-

* The agreement between the *Hectocotyli* of the two species which have the swimming-membrane between the two uppermost pairs of arms so strongly developed, may serve provisionally as a support for a different distribution of the species under the two generic names *Tremoctopus* and *Philonexis*, somewhat as has been attempted by Gray, Mollusca of the British Museum, pp. 24–27.

ception or transfer of the seminal mass*. But in all this we have nothing but indications. I must content myself with having pointed out generally all the formations and agreements here described, and leaving it to those who possess richer materials, and especially to naturalists living on the sea-coasts, particularly that of the Mediterranean, who are fortunate enough to observe these animals daily in a state of nature, to carry out the comparison in all its details, I will only append to the above series of observations the general remarks to which they appear to lead me at the moment.

In the first place, it follows clearly, from these observations, that the *Hectocotylus*-formation in *Argonauta* and *Tremoctopus* is a far less paradoxical phænomenon than it was supposed to be by naturalists, nor does it occur so suddenly and without transitions, as appeared at first, and as has hitherto been stated. We see rather that the peculiarity, so strange and anomalous at the first glance, is here, as throughout Nature, prepared and brought about by a series of transitions. It appears that it is only a stronger expression, in particular spots, for that which is expressed more or less distinctly in numerous other points in the vicinity†.

In the consideration of the *Hectocotylus*-formation in *Argonauta*, the modification and transformation taking place here of an organ originally connected with motion and nutrition, into an organ of reproduction, has frequently been compared with the alteration in form and function which the palpi undergo in the male Spiders, by certain parts of them becoming transformed into spoon-shaped organs, which are employed for the reception

* I may, however, refer to the abundant and interesting literature of the last few years upon the three known species of *Hectocotylus*, and especially to—

Kölliker, Berichte von der königl. zootomischen Anstalt zu Würzburg, 1849.

Verany, Mollusques Méditerranéens, 1851, P. 41. p. 126-128.

H. Müller, Zeitschr. für Wiss. Zool. 1853, p. 1–35, & p. 346–358. taf. 1. (See also Verhandl. der physikalisch-medicinischen Gesellsch. zu Würzburg, 1851; Annales des Sciences Naturelles, tom. xvi. 1851, and Scientific Memoirs, new series.)

Verany and Vogt, Annales des Sciences Naturelles, tom. xvii. 1852, p. 148–185. pl. 6–9 (and Scientific Memoirs, new series).

Leuckart, Zoologische Untersuchungen, iii. 1854, p. 91–109. taf. 2. fig. 19–22. (See H. Müller, Verhandl. der phys.-med. Gesellsch. zu Würzburg, 1854, p. 332.)

† The entire developmental series in this respect in the Cuttle-fishes is similar to that which I have indicated with regard to the breeding of the Frogs and Toads, in which the care of the male of *Alytes obstetricans* for the eggs, evidently originates from, or is in relation with, the obstetric assistance which all the species render to their females.

of the semen and its transference to the female*. It appears to me, however, that an analogy as close, or perhaps closer than this, which has already been made use of by Leuckart, Owen, Von Siebold, and others, is that which occurs in so many males amongst the Decapod Crustacea, in which a pair of abdominal limbs is converted into more or less complete tubes; or in the males of the Rays and Sharks, in which it is the ventral fins, and therefore an active motory apparatus, that become converted on one side into large conducting-tubes for the semen. In both cases the organs very nearly represent the structure in *Octopus* and *Eledone*. If we imagine these long hollow tubes formed for the transfer of the semen, remaining, in copulation, attached to the female, we have the condition of the parts as in *Argonauta*. That parts of the male member which are destined to the actual insemination or introduction of the semen into the female sexual organs, may be detached during this introduction, and remain in the female, is perhaps not unexampled; the circumstances described as occurring in many insects at least offer a distant analogy herewith; but in the males of insects, whose life is closed with the first and only copulation, there can be no question of a new growth or reproduction of the lost parts.

Moreover, that it is in genera of Octopods that we have an example of a regeneration of the arm lost in copulation, is deserving of attention, inasmuch as by this we are reminded of a difference between the Octopoda and Decapoda, which is not unessential, but has not hitherto been rendered sufficiently prominent. *Thus all the Decapoda appear to be incapable of replacing accidental injuries of the arms, or the loss of parts of them, by a new growth, whilst the Octopoda possess this power in the highest degree,* and reproduce their arms, which are exposed to so many enemies, with the same facility and rapidity as, for example, the Star-fishes.

Amongst numerous Octopoda I have never seen a single one with the arms injured or bitten off, without a reproduction being commenced, more or less advanced, or even completed; and this sometimes on most of the arms†. In more than a hundred Decapoda which I have at present examined, I have, on the contrary, never found a trace of a reproduction, although

* A still closer analogy seems to exist with some of the Myriapoda, such as *Polydesmus*, in which, according to M. Fabre (see Annals, Feb. 1857, p. 162), the semen is transferred to the female by the first pair of feet of the seventh segment.—W. S. D.

† I have seen female individuals in which all the eight arms had been lost, but in which they were more or less completely reproduced; and I have seen a male in which the same was the case on the seven arms, whilst the hectocotylized arm alone was uninjured: whether this was something accidental, or whether the Octopods do not place this peculiar arm of theirs in so much danger as the others, I must leave unanswered; but it de-

I now and then found both large and small portions of a single arm lost, and the wounded surfaces healed.

From the different forms of the pair of arms metamorphosed for the purpose of reproduction, it appears that there is an unmistakeable connexion between the position and extent occupied by the metamorphosed part of the arm, and the natural group to which the particular Cephalopod belongs. This appears with peculiar distinctness when the above-described peculiarities are placed in apposition with D'Orbigny's classification of the Cephalopoda.

OCTOPODA*.

Philonexidæ { *Argonauta* / (Philonexis) / *Tremoctopus* } third { left / right } arm a Hectocotylus† (feminæ polyandræ!).

Octopidæ { *Octopus* / *Eledone* } third right arm hectocotylized‡ (feminæ monandræ?).

DECAPODA.

Myopsidæ

Rossia	first left arm hectocotylized	(with the right one, only in the middle).
Sepiola		(alone, in its whole length).
Sepia	fourth left arm hectocotylized	(at the base).
Sepioteuthis		(at the apex).
Loligo		(at the apex).
Loliolus		(in its whole length).

Oigopsidæ { *Ommatostrephes* / *Onychoteuthis* / *Loligopsis* } No hectocotylized arm hitherto observed.

* I have not referred here to the *Sciadephorus Müller*i, Eschr. (*Cirroteuthis*), a form differing completely from the rest of the Cephalopoda. I have certainly examined four males, and found no trace of the formation of the arm indicated in *Octopus* and *Eledone*, but I cannot assert with certainty that it would not be found on living examples. The peculiar texture of this genus causes all its parts to alter greatly in spirits. As something very remarkable, I must observe, that my four male specimens had, as it were, stripped off a portion of the small acetabula on the lower third of the arm, thus forming small plate-like surfaces,—an appearance which none of my females presented. Whether this might be a sexual character, I am unable to say. The genus appears to form a peculiar family of the Octopoda, although it will be seen, from my present investigations, that it approaches *Eledone* not only by the single series of acetabula, but also by the cirri which I have indicated at the apex of the arm in *Eledone*, and which in *Sciadephorus* appear to represent the greater part of the arm.

† Deciduous, colourless, developed in a sac.

‡ Permanently attached, coloured, developed in a free state.

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serves to be remarked, that whilst as a rule every Octopod has one or two arms reproduced, none of the numerous males which I have examined presented this arm in an injured or reproduced state.

The reproduction takes place with much ease, not only in the direction

This summary furnishes a very striking evidence that there must be something natural in D'Orbigny's division of the Decapod Cephalopoda into the two principal groups, "*Myopsides*" and "*Oigopsides*," although no great inclination to adopt them has hitherto been shown. The difference in the conditions of reproduction shows especially that the genus *Ommatostrephes*, D'Orb., is still more entitled to be removed far from the genus *Loligo*, with which even modern malacologists, such as Verany and Troschel, persist in placing it. D'Orbigny repeatedly points out that his genus *Philonexis* or *Tremoctopus* is essentially distinct from *Octopus*, under which genus its species were formerly arranged, and closely approaches *Argonauta*; and the above-mentioned conditions of reproduction also show this completely; and in reference to this, it is very interesting to observe that the supposed *Octopus*, in which Verany has described the complete *Hectocotylus*-development, namely *O. Carenæ*, Ver., has proved to be a *Philonexis* or *Tremoctopus*. If, therefore, D'Orbigny's division into great groups finds much confirmation in the above-described peculiarities, these should also furnish many hints for a probably more natural limitation of the particular families, and this applies especially to the collocation of the genus *Sepia* with *Rossia* and *Sepiola*, which, however, has appeared less natural to many. The negative characters which united these three genera in opposition to the other *Myopsidæ*, have already lost something of their strength, as the want of the muscular cords on the funnel has been detected in the small

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of the axis of the arm; but even a single sucker or a group of suckers, which their enemies may have bitten from the sides or the base of the arm, is reproduced with the greatest facility.

I have already called attention to the misinterpretations of Aristotle, where he has been understood as if, in his representations of the circumstances of reproduction in his Polypus, he had in his eye a *Hectocotylus*-formation, such as we are now acquainted with in *Argonauta* and *Tremoctopus*. This appears to me to be the place to clear up, as far as possible, another misconception which stands in connexion with the preceding. Roulin (Ann. des Sc. Nat. xvii. p. 189), namely, supposes that it is the observation of male *Octopods* from which the *Hectocotylus* had separated, and which therefore had lost one arm, that gave rise to the story referred to by Aristotle, that at certain times, especially in winter, when the *Octopus* retracts itself more into its cavities, it bites off its own arms, and to Aristotle's view—by which he endeavours to explain the origin of the story—that it is the voracious eels that bite off the arms of the animal. The foundation of both the story and its explanation is of course neither more nor less than the frequent and striking injuries and renovations in the common *Octopus*, and Aristotle's explanation is correct, as the stomachs of the *Murænæ* are found filled with fragments of the arms. "Ego vero," says the excellent Belon, "cum apud Epidaurum semel Murænas secarem, earum ventriculos cirrhis polyporum refertos comperi." (P. Bellonii de Aquatilibus, libri duo. Paris, 1553, p. 331.)

genus *Loliolus* in the *Loligo*-family. The justification of the mode here adopted of employing the hectocotylized arm as a rule for the natural collocation of the forms, lies in its importance for the entire reproduction. It would be inconceivable that the various occurrence of this metamorphosis, sometimes in one, sometimes in the other pair of arms, sometimes on the right and sometimes on the left side, sometimes at the apex and sometimes at the base of the arm, &c., should not give rise to the same number of differences in the mode of fecundation, and in the position and manner in which the seminal mass is placed upon the female; inasmuch as it appears that the semen is hardly involuntarily or mechanically emitted or poured out upon the eggs, but that this is effected by conscious movements. What is furnished us in this respect by simple reflection, is also confirmed by observation. The seminal mass is actually attached to very different parts, and under very different conditions, which I propose to describe shortly in another memoir, of which I shall here only give the general result, that in the genera *Sepia*, *Sepioteuthis*, and *Loligo*, and therefore in all those which have the left arm metamorphosed, the seminal mass is attached to the lips of the female (*membrane buccale*, D'Orb.), which therefore appear peculiarly equipped for this purpose, whilst I have never found the semen attached to this spot in any other Decapod, but on various parts of the mantle or of the viscera; for example, in *Ommatostrephes*, deep in the cavity of the mantle in the median line of the back. For comparison with what has here been stated with regard to *Sepia* and the *Loligines*, it must be remembered that the anatomical examination of the two male specimens of *Nautilus** has shown a great difference in the development of the peculiar labial portions on the two sides of the animal, whilst nothing of the kind occurs in female individuals.

Although the external sexual distinctions above referred to have proved to be distinct and important, they have not hitherto been perceived by naturalists; most of them will at least agree with me in regarding them as such, after reading the preceding. To show more distinctly this deficiency in our present knowledge of the Cephalopoda, it will hardly be superfluous, although I trust that it may be considered quite sufficient for this purpose, to quote two of the most modern assertions relating to this subject; they are dated in the last and in the present year, and will, in my opinion, completely prove the position of science for the time at which they were written. In the new edition of his

* Vide Van der Hoeven in Tijdschrift voor de Wis- en Natuurk. Wetenschappen, I. Deel, 1848, p. 67–75. pl. 1. fig. 1–3, and Transactions of the Zoological Society, 1850, p. 21–29. pl. 5–8.

"Lectures on Comparative Anatomy and Physiology, London, 1855," the celebrated English anatomist, Professor Owen, has no peculiarity in the Octopoda and Decapoda to place beside the sexual distinctions so often referred to in *Argonauta* and *Tremoctopus*, except the following:—"In the Calamary (*Loligo vulgaris*) the gladius of the male is one-fourth shorter, but is broader than that of the female. The sepium of the Cuttle (*Sepia*) shows a similar, but not so much, sexual difference in its proportions," p. 628; so that of such characters he is only acquainted with the greater or less breadth of the gladius, according to the sexes. Still less has Professor Leuckart to place beside this sexual peculiarity in *Argonauta* and *Tremoctopus*. In his "Nachträge und Berichtigungen zu dem ersten Bande von J. Van der Hoeven's Handbuch der Zoologie, Leipzig, 1856," which have just appeared, I find that this author, so well known by his observations upon the sexes and reproduction of the sea animals, says, in connexion with the above-mentioned two genera: "Amongst the other Mollusca no instances of a sexual dimorphism have yet been observed, for the difference in the formation of the labial tentacles in the male *Nautilus*, pointed out by Van der Hoeven, and recently confirmed (according to his letters) ..... can scarcely be placed beside the remarkable peculiarities of those Cephalopoda."

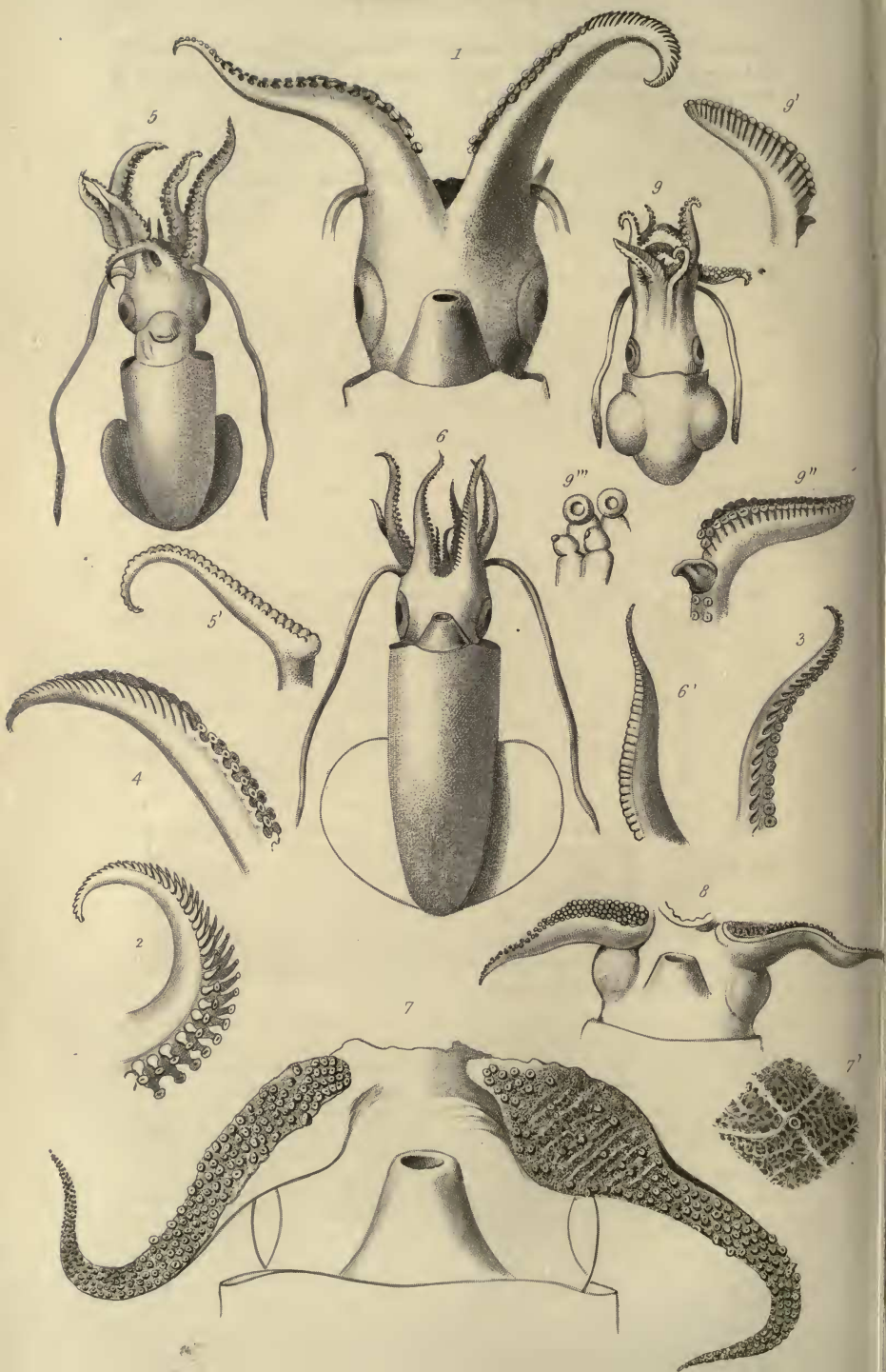
But the more these peculiarities have been overlooked, the more does the question arise, how can they have escaped observation? and, as the answer to this, I must state that I suppose that they must really have been frequently noticed by naturalists, but that they must have regarded them as *morbid developments* or *accidental mutilations*, of which the traces had not been effaced by regeneration. I have already stated that D'Orbigny has indicated as a disease, what in my opinion is a character of the reproductive males in the genus *Sepiola*; and that the short, hectocotylized arm of *Octopus* and *Eledone* has been regarded as an injured or mutilated arm, the lost terminal portion of which had not yet grown, appears to me to follow distinctly enough, although indirectly, from the numerous figures of these animals possessed by science. I have been unable to find a single one of these with a male arm of this description; and as it is inconceivable that, especially amongst so many Octopods figured in such different places and at such different periods, there should not have been a single male (although these appear to me to be at least as abundant as the females), the artists or naturalists must, in order to complete the animal, have given it the symmetry which they supposed to belong to it. This applies also to the form of the left arm in the male *Loligines* and *Sepiæ*, and the more so as, according to the text and the lettering of the plates,

many of these figures represent males, whilst the arms are given as symmetrical. Amongst the Decapoda, however, a case often occurs, which may have led to an erroneous conception of the symmetrical development, namely that considerable portions of the suckers of the arms, and especially towards their apices, appear as if bitten off during the powerful movements and exertions of the animal when it finds itself captured or in great danger; and that the metamorphosed, papilliferous part of the arm in a *Loligo* or a *Sepioteuthis* might easily be confounded with such parts deprived of their suckers, at least on a rather superficial examination*.

The preceding assertions must only be understood in reference to the existence of this peculiarity, and it must be borne in mind that it was much better known at a period of high antiquity. That Aristotle, and perhaps Pliny, were better informed by the fishermen of the Mediterranean, as to a peculiar arm in the genus *Octopus*, I have already pointed out under that genus, and at the same time called attention to the fact that Aristotle knew for what purpose this arm was employed.

As the question so easily arises, how early in the life of the animal this transfer of the arm into the service of reproduction occurs, and how far it remains constantly in the same condition, or perhaps undergoes changes at the season of propagation, I must add in conclusion, that the numerous specimens which I have examined with this view have given me no inducement to suppose that any alteration takes place according to the season of the year or the age of the animal. Even my smallest specimens of a species exhibit the same characters as the largest, and I find myself compelled to assume that the male young of the different genera and species quit the egg already furnished with *the* hectocotylized arm which belongs to them by virtue of their genus or species. As an adherent of the theory that the sex is not subsequently developed, but that it is present originally from the first movements in the egg, I should have preferred being able to ascertain by direct observations that the young of the Cephalopoda quit the egg with their external sexual characters; but I have only had the opportunity of examining the

* In *Loligo*, as well as in *Ommatostrephes* and *Onychoteuthis*, I have found the cavity of the mouth and the œsophagus filled with acetabula and horny rings or hooks, evidently belonging to the same animal, and the place of which on the arms could still be determined. From this we see that we must be very cautious in stating that the Cephalopoda serve as the food of these animals because single horny rings or hooks of this kind are found in their stomachs; but if fragments of the beak, of the gladius, and the lenses of the eyes are found, as has often been done by me in certain forms, no such misinterpretation can take place.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